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INTERNATIONAL APPLICATION PUBLISHED UNDER THE PATENT COOPERATION TREATY (PCT)

(51) International Patent Classification 6 :
B01D 3/06, 1/12, 1/28, 1/00, 5/00, 19/02, C02F 1/04

A1

(11) International Publication Number: **WO 97/20606**

(43) International Publication Date: 12 June 1997 (12.06.97)

(21) International Application Number: PCT/EP96/05385

(22) International Filing Date: 4 December 1996 (04.12.96)

(30) Priority Data:
TO95A000974 6 December 1995 (06.12.95) IT

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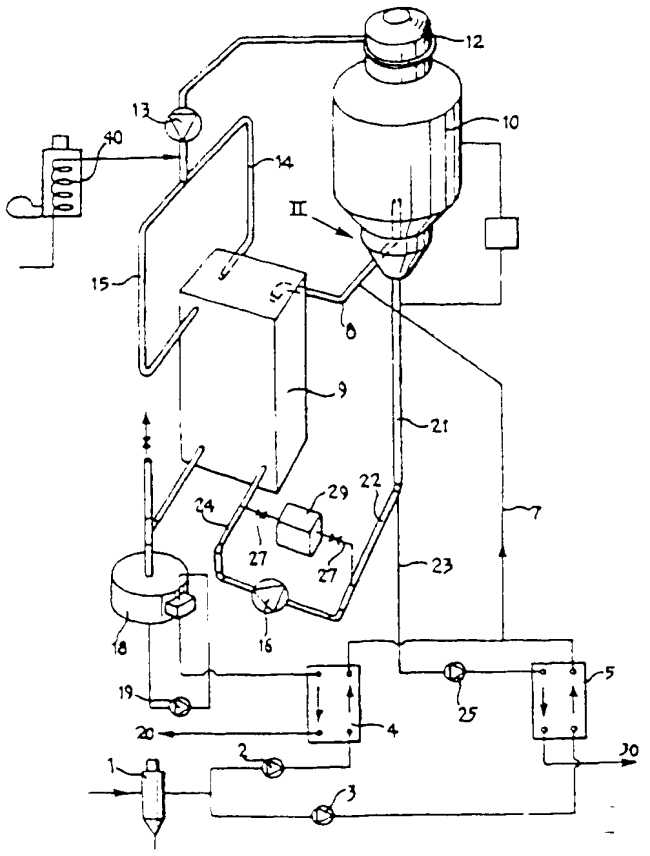
(81) Designated States: AL, AM, AT, AU, AZ, BA, BB, BG, BR, BY, CA, CH, CN, CU, CZ, DE, DK, EE, ES, FI, GB, GE, HU, IL, IS, JP, KE, KG, KP, KR, KZ, LC, LK, LR, LS, LT, LU, LV, MD, MG, MK, MN, MW, MX, NO, NZ, PL, PT, RO, RU, SD, SE, SG, SI, SK, TJ, TM, TR, TT, UA, UG, US, UZ, VN, ARIPO patent (KE, LS, MW, SD, SZ, UG), Eurasian patent (AM, AZ, BY, KG, KZ, MD, RU, TJ, TM), European patent (AT, BE, CH, DE, DK, ES, FI, FR, GB, GR, IE, IT, LU, MC, NL, PT, SE), OAPI patent (BF, BJ, CF, CG, CI, CM, GA, GN, ML, MR, NE, SN, TD, TG).

Published
With international search report.
Before the expiration of the time limit for amending the claims and to be republished in the event of the receipt of amendments.

(54) Title: A METHOD AND A DEVICE FOR PURIFYING WATER

(57) Abstract

Water to be purified is sent into an evaporator (10), causing heating thereof and at least partial transformation into steam with consequent concentration of the liquid phase. The steam is then compressed (13) and sent to a heat exchanger (9) so as to give up its latent heat to the incoming water, with consequent condensation of the steam. The concentrated liquid phase (30) and the condensed steam (20) are drawn off (25, 19) for subsequent re-use.



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A method and a device for purifying water

The present invention relates in general to the purification of water and, in particular, relates to the purification of water contained in percolates originating from solid urban waste or from the desalination of sea-water, or of water originating from industrial processes.

The object of the present invention is to provide means for purifying the aforementioned waters cheaply and very efficiently.

The present invention provides such means by virtue of a method and a device having the specific characteristics recited in the following claims.

The invention enables a concentrate and a distillate suitable for advantageous re-use to be produced from the water to be processed. The concentrate can be handled easily whereas the distillate can be discharged into the surface waters after simple treatment by means of an activated-carbon filter or other simple chemico/physical or biological after-treatment.

Further characteristics and advantages of the present invention will become clear in the course of the following detailed description, given purely by way of non-limiting example, with reference to the appended drawings, in which:

Figure 1 is a schematic view of the structure of a device for purifying water according to the invention, and

Figure 2 shows a detail indicated II in Figure 1, on an enlarged scale.

With reference to Figures 1 and 2, the water to be treated is sent to a self-cleaning filter 1 for removing any coarse solids from the water.

The water leaving from the filter 1 is sent, by means of pumps 2 and 3, to first and second heat exchangers 4 and 5 which have the function of pre-heating it for introduction into the main circuit of the device. The water thus passes through the cold sides of the heat exchangers 4 and 5, through the hot sides of which the condensate and the concentrate produced by the purification pass, respectively, as will be seen below. The heat exchangers 4 and 5 are usually constituted by plate-type exchangers.

The preheated water to be treated is sent through a pipe 7 into a further pipe 8, the function of which will be explained below.

The pipe 8 connects the upper portion of a heat exchanger 9 to a chamber (drum) 10 in which the at least partial transformation of the water to be treated is completed with the formation of a liquid condensate phase. The heat exchanger 9 may advantageously be of the plate type.

The pipe 8 thus feeds both the preheated water to be treated and a fraction of concentrate coming from the heat exchanger 9 to the chamber 10, as will be explained below. The aforementioned mixture emerges from the pipe 8 into the chamber 10, possibly with the formation of bubbles. However, above the outlet opening of the pipe 8, there is a deflector screen 11 which is struck by the flow coming out of the pipe 8 so that a liquid barrier to

any foam is created.

The solution of the use of a screen to prevent the formation of foam may be considered known; it has, however, been found that the provision of a screen 11 having a generally arcuate shape (see Figure 2) arranged like a roof over the outlet of the pipe 8 is preferable for the purposes of the implementation of the invention.

The vapour phase formed inside the chamber 10 tends to come out of the upper end of the chamber 10, to which a demister element 12, also of known type, is connected. The function of the element 12 is to prevent the steam emerging from the chamber 10 from entraining liquid particles towards a compression stage for mechanically compressing the steam, raising its temperature.

In the embodiment illustrated, which has been found particularly advantageous in practice, the stage in question comprises a compressor 13 which may be a positive-displacement, side-duct, or centrifugal compressor, according to the flow-rates involved and to the characteristics of the fluid treated in the plant.

As a result of its passage through the compressor 13, the steam is brought to a temperature of the order of 115-130°C and reaches the hot side of the heat exchanger 9 through pipes 14 and 15.

As a result of its passage through the heat exchanger 9, the steam compressed by the pump 13 gives up its latent heat to the water circulating on the cold side, and condenses. The condensate is discharged into a

discharge device 18 in order to be sent, by means of a pump 14, towards the distillate output line 20 after passing through the hot side of the heat exchanger 4. In the heat exchanger 4, the condensate coming from the discharger 18 gives up its considerable heat to the water pumped by the pump 2 helping to preheat it before it is introduced into the pipe 7, as already described above.

A fraction of the condensate is retained in an auxiliary tank (not shown) to enable the plant to be started up as will be described further below.

The concentrated liquid phase which collects in the lower portion of the chamber 10 leaves it through a pipe 21 which branches into two pipes 22 and 23, sending respective portions to the heat exchanger 9 by means of a pump 16 and a pipe 24, and to the hot side of the heat exchanger 5 by means of a pump 25. The pump 25 can draw off the purification concentrate selectively (that is, with a certain flow-rate).

In parallel with the pipes 22 and 24 there is a further pipe 27 with a refractometer 29 which continuously monitors the concentration of the product being processed. The refractometer 29 controls the flow-rates of the pumps 25 and 3 by known means, not shown for simplicity, ensuring a modulated discharge of the concentrate and optimal recovery of heat for the incoming product. The desired degree of concentration is adjustable; extraction of the concentrate starts only when a pre-set concentration value is exceeded.

The concentrate drawn off by the pump 25 passes into the

hot side of the heat exchanger 6 and is sent to the collection zone 30. For cold starting of the plant, it may be useful to use a small boiler of the instantaneous coil type 40 which sends steam, for example at superheated state, upstream of the heat exchanger 6 until the plant has been brought up to the working temperature (over 100°C). The burner of the boiler 40 may be supplied with, for example, gas oil. The steam is produced with a small portion of the distilled water generated, the boiler being turned off when the running temperature is reached. The plant as a whole can be controlled by a computer and is therefore fully automated.

Naturally, the principle of the invention remaining the same, the forms of embodiment and details of construction may be varied widely without thereby departing from the scope of the present invention.

CLAIMS

1. A method of purifying water, characterized in that it comprises the steps of:

- preheating the water in at least one heat exchanger (4, 5),

- injecting the preheated water into a separator, evaporator (10) with consequent at least partial transformation into steam and therefore concentration of the liquid phase,

- compressing the steam (13),

- sending the compressed steam into a heat exchanger (9) so that the steam gives up its latent heat to the concentrate of the water to be purified coming from the evaporator (10) and sent into the heat exchanger (9), with consequent condensation of the steam, and

- drawing off the concentrated liquid phase (30) and the condensed steam (20).

2. A method according to Claim 1, characterized in that the steam is compressed (13) bringing about a rise in its temperature into the range of approximately 100-130°C.

3. A method according to any one of the preceding claims, characterized in that it comprises the step of causing water to circulate (7, 8, 10) through the heat exchanger (9) and a chamber (10) for evaporation and concentration of the liquid phase, water to be purified being added

downstream (18) of the heat exchanger (9) and the concentrated liquid phase being drawn off downstream (23) of the evaporation and concentration chamber (10).

4. A method according to any one of the preceding claims, characterized in that it comprises the step of detecting (27, 29) the concentration of the concentrated liquid phase, and the step of drawing off the concentrated liquid phase (23) in dependence upon the concentration detected (27, 29).

5. A method according to any one of the preceding claims, characterized in that it comprises the step of generating (40) an initial quantity of steam for introduction into the heat exchanger (9) in order to start the method.

6. A device for purifying water, characterized in that it comprises:

- an evaporator (10) which is intended to be supplied with the water to be purified so as to bring about heating thereof with at least partial transformation into steam and consequent concentration of the liquid phase,

- first compressor means (13) for compressing the steam and sending the compressed steam towards a heat exchanger (9) to which the concentrate coming from the evaporator (10) is sent, the heat exchanger (9) sending the heated concentrate towards the evaporator (10), together with the water to be purified, hot distilled water coming out of the exchanger,

- a collector (18) for the hot distilled water,

- second compressor means (25) for drawing off a fraction of the concentrated liquid output from the evaporator (10),

- means for drawing off the concentrated liquid phase (30) and the condensed steam (20).

7. A device according to Claim 6, characterized in that it comprises first (4) and second (5) heat exchangers for preheating the water to be purified, the condensed steam and the concentrated liquid, respectively, passing through their hot sides.

8. A device according to Claim 6 or Claim 7, characterized in that the said damping means are constituted essentially by a screen (11) disposed in a position facing the outlet of the pipe (8).

9. A device according to Claim 8, characterized in that the screen (11) has a generally arcuate shape.

10. A device according to any one of Claims 6 to 9, characterized in that at least one demister element (12) is interposed between the chamber (10) and the compressor means (13) to prevent entrainment of liquids towards the compressor means (13) with the steam.

11. A device according to any one of Claims 6 to 10, characterized in that refractometric measurement means (29) associated with the means for drawing off the concentrated liquid phase can detect the degree of concentration of the concentrated liquid phase, causing the concentrated liquid phase to be drawn off (23) in

dependence upon the degree of refraction detected.

12. A device according to any one of Claims 5 to 11, characterized in that it comprises an auxiliary heating unit (40) for generating a quantity of steam which can be supplied to the heat exchanger (9) to start and maintain the at least partial transformation of the water to be purified into steam as a result of its passage through the heat exchanger (9).

FIG. 1

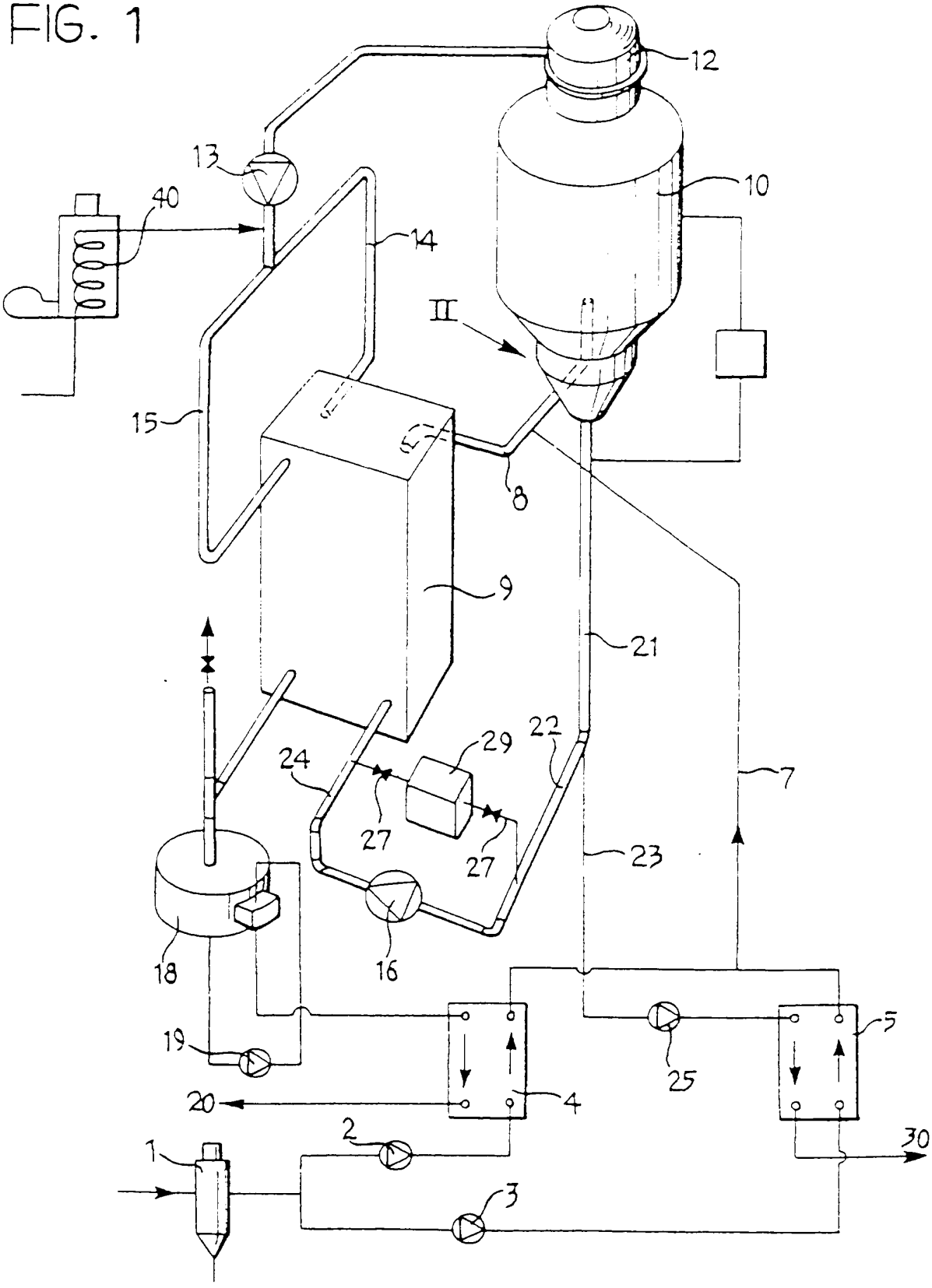
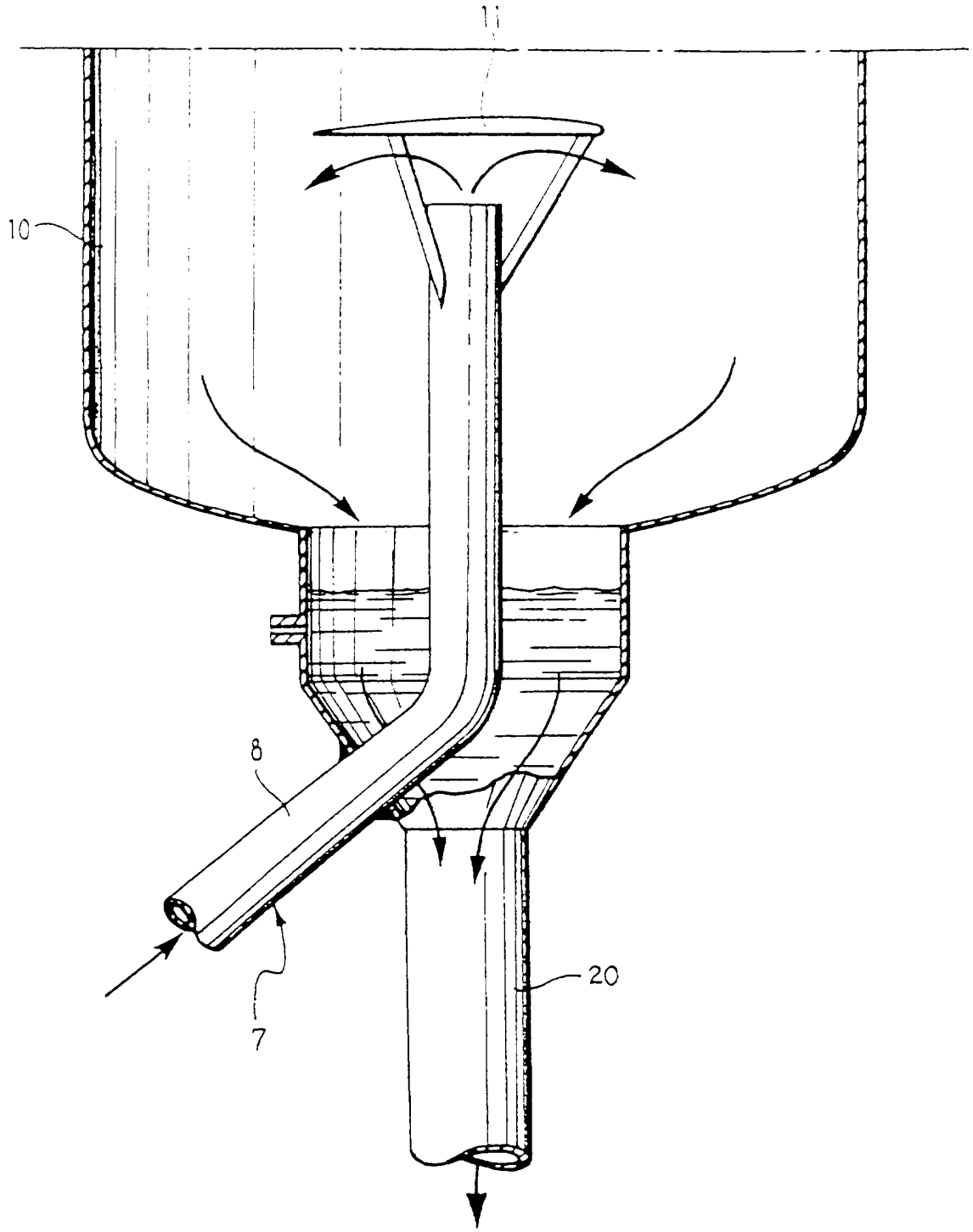


FIG. 2



INTERNATIONAL SEARCH REPORT

International Application No
PCT/EP 96/05385

A. CLASSIFICATION OF SUBJECT MATTER
IPC 6 B01D3/06 B01D1/12 B01D1/28 B01D1/00 B01D5/00
B01D19/02 C02F1/04

According to International Patent Classification (IPC) or to both national classification and IPC

B. FIELDS SEARCHED

Minimum documentation searched (classification system followed by classification symbols)
IPC 6 B01D C02F

Documentation searched other than minimum documentation to the extent that such documents are included in the fields searched

Electronic data base consulted during the international search (name of data base and, where practical, search terms used)

C. DOCUMENTS CONSIDERED TO BE RELEVANT

Category *	Citation of document, with indication, where appropriate, of the relevant passages	Relevant to claim No.
Y	WO 93 24198 A (TRANSFERON WASCHEREIMASCHINEN GMBH) 9 December 1993	1,6,10
A	see page 8, line 24 - page 11, line 9; figure 1	4,7,11

Y	EP 0 142 251 A (OY-FINN-AQUA LTD) 22 May 1985	1,6,10
A	see page 6, line 3 - page 8, line 11; figure	2,3

X	WO 92 10264 A (AQUAMAX OY) 25 June 1992 Abstract see figure 1	1,6,7

A	DE 72 16 268 U (FELD & HAHN GMBH) 31 July 1986 see figures	8

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[X] Further documents are listed in the continuation of box C.

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Date of the actual completion of the international search	Date of mailing of the international search report
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Category	Citation of document, with indication, where appropriate, of the relevant passages	Relevant to claim No.
A	US 4 551 198 A (WILLIAM E. WILEY) 5 November 1985 see figures 1,3	8

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Information on patent family members

Inter... Application No
PCT/EP 96/05385

Patent document cited in search report	Publication date	Patent family member(s)	Publication date
WO 9324198 A	09-12-93	DE 4218451 A	09-12-93
EP 142251 A	22-05-85	JP 60090003 A	21-05-85
WO 9210264 A	25-06-92	FI 86961 C	01-08-94
		AT 134142 T	15-02-96
		AT 149857 T	15-03-97
		AU 648856 B	05-05-94
		AU 9048391 A	08-07-92
		AU 655956 B	19-01-95
		AU 9066391 A	08-07-92
		BG 97866 A	30-06-94
		BG 97867 A	30-06-94
		CA 2098288 A	15-06-92
		CA 2098289 A	15-06-92
		DE 69117196 D	28-03-96
		DE 69117196 T	04-07-96
		EP 0639096 A	22-02-95
		EP 0639097 A	22-02-95
		ES 2083727 T	16-04-96
		WO 9210265 A	25-06-92
		HU 66709 A,B	28-12-94
		HU 66707 A	28-12-94
		JP 6503265 T	14-04-94
		JP 6503266 T	14-04-94
		NO 180519 B	27-01-97
		US 5512141 A	30-04-96
DE 7216268 U	19-06-86	NONE	
US 4551198 A	05-11-85	CA 1209421 A	12-08-86